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The Use of Compost to Remediate Mining Sites-A Review of Current Research

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The purpose of this paper is to summarize two key pieces of research analyzing the applicability of the use of compost to remediate mining sites. This paper represents the best professional judgement of the authors and may not represent the official position of the U.S. Environmental Protection Agency.

There are over 1,500 operating non coal mining sites in the U.S. There may be an additional 200,000 to 300,000 abandoned mines in the U.S of which as many as 2,000 may require significant environmental clean-up. As of 2001, there are approximately 60 mining and mineral processing sites on the National Priorities List (NPL), often referred to as the Superfund List. The mining sites on the National Priorities List are among the largest and most costly of all of the sites on the NPL. It is clear that the cost to clean up operating and abandoned mines far exceeds the resources of state and federal governments. There is therefore a need to identify remediation approaches which can reduce the contamination at very large mine sites while at the same time are cost effective. The use of compost appears to offer promise in addressing these needs.

There is considerable confusion over what “compost” is. Thermophilic compost is not the random decay of vegetative matter. During the thermophilic process both pathogens and weed are destroyed. During the curing of the compost, microorganisms are multiplied by about 100 fold. Compost is <u>not</u> biosolids. Biosolids are treated waste water treatment plant sludges. There has been a lot of research on the application of sludges to remediate disturbed lands and the EPA has set regulatory limits on the pathogens and metal content of sludges used for agricultural purposes.

The first research effort related to compost remediation of mining wastes is currently being conducted by MSE Technology Applications, Inc of Butte Montana (www.mse-ta.com). This research is supported under a grant from EPA and DOE and is referred to as Project 23. The purpose of this three year effort is to compare the effective action of compost and biosolids to treat mine tailings. Two sites were chosen, Big River Mine Tailings (an NPL site) and Leadwood both in Missouri. The Big River site contains fine grained tailings while the Leadwood site contains coarse tailings. Both types of tailings have elevated concentrations of lead and cadmium. Vegetation at these sites is virtually nonexistent due to the contamination of metals, lack of nutrients, and poor soil profile.

Forty test plots were established. An inorganic fertilizer was initially applied to all test plots to provide a base level of plant micro-nutrients. Then each plot was given an application of milorganite (treated biosolids), ormiorganic compost (mixed residential yard wastes) and St Peters compost (40% biosolids, 60% mixed yard wastes) were analyzed. Three compost application rates were used, low (1 inch or 133 cubic yards per acre), medium (1.5 inches or 200 cubic yards per acre) and high (2 inches or 266 cubic yards per acre). Milorganite was applies at 1,450 pounds per acre, 2,200 pounds per acre, and 2,900 pounds per acre. Each test plot was then seeded with a tall fescue. Plants were harvested to analyze metals uptake and soli cores were taken to determine if applications affects total metals concentrations. The results below reflect the first full growing season and were released in July 2001. Results clearly indicate that average metal uptake of cadmium, lead, and zinc was reduced in plant uptake on compost treated plots. Average metal concentrations for the three application rates of compost were approximately two-thirds those of the control plots. This study also shows that non of the applications appear to change the concentrations of metals in the soil. Both compost applications did increase total organic carbon (TOC) by a factor of 2.6 compared to the control, and compost also decreased pH approximately 0.7 of a unit compared to the controls. Vegetative cover on all of the composted plots was excellent however composted plots had denser cover. Due to a drought condition all plots were irrigated. At this point in time this research shows that the use of compost or compost mixed with biosolids appears to significantly reduce the up take of metals into plants while at the same time improving the soil profile. While the research does not show that metals concentrations in the soil are reduced, application of compost clearly shows promise as a means of covering large areas contaminated with metals to encourage vegetative cover and reduce runoff of metals into streams. It will take further research to determine if long term vegetative cover will reduce downward movement of metals into groundwater.

The second research effort was funded by EPA and the US Forest Service entitled, The Effects fo Composted Organic Materials on the Growth Factor for hardwood and Softwood Tree Seedlings. The report was published October 1999. Three mountainous test sites in the Nantahala National Forest in western North Carolina were chosen to analyze the effect of the application of compost on growth rates fo trees. One site was a clear cut site, another was a log landing area devoid of all top soil, and a the third site was a rocky north slope. The study began in December 1994 and ended in the summer of 1998. Three different composts were applied to test plots: biosolids, a yard compost (composed of shredded leaves, grass, and tree trimmings), and a compost mixed with municipal solid waste. Application rate on plots was approximately 2 inches. Straw was applied to test plots as a control. White pine, Chestnut and Chinese chestnut seedlings were planted. Three year height growth of trees was lowest for straw and highest (40 inches) for MSW compost. Three year diameter was again lowest for straw . Pines diameters were highest for yard compost , while chestnut oak diameter were highest on MSW. Of particular note is the degree of herbaceous growth cover on plots. Significant high cover occurred on biosolids sites and it appears that such dense growth may have retarded the growth of trees. Yard and MSW plots had 80 and 60 percent cover while straw had 50 percent cover and untreated plots had 45 percent cover. Clearly compost aided in vegetative cover but did not adversely affect tree growth. At the end of three years there was no visible signs of erosion of composted plots. Some straw plots showed erosion at the end of the test period. Soil samples taken from the center of each of the 24 plots after 2 years (in November 1996) showed that composted plots had 140 percent greater organic matter than control plots. Soil pH also showed improvement with plots using compost having a pH mean of 5.1 while plots treated with straw had a pH mean of 4.75. An error of application of one inch MSW compost occurred at all of the sites. This unanticipated application of compost resulted in the highest growth rate for trees in one plot. Average tree growth in this plot was slightly over 100 inches and 0.89 inches in diameter. This event indicates that further research is needed to determine the optimum application rate for compost. Clearly higher application rates appear to stimulate tree growth. This research also showed that higher value hardwood trees clearly grew more quickly and survived better on plots treated with compost compared with straw. It is further apparent that if disturbed soils have compost worked into it in addition to a surface application of compost, tree growth of hard and soft wood trees would be significantly better than straw even on soils with borderline nutrient levels. This study supports the conclusion that the use of compost increases the growth of hard and soft wood trees on disturbed low nutrient soils.

Conclusion

The MSE study gives excellent data showing that the application of compost stimulates vegetative cover while at the same time improving soil characteristics and reducing metal uptake in vegetation. The EPA/FS study shows that higher value hard wood trees can thrive when planted with compost. It is apparent that the use of compost at mine sites may be cost effective since such applications can now help to create areas of mixed grasses and trees which could be used for commercial tree farming as well as for a wide variety of outdoor recreation uses. These studies provide enough data that large scale pilot applications of compost should be assessed at mine sites to determine if their use is in fact a low cost alternative to classic remediation alternatives.

We urge readers to directly contact MSE, the Forest Service and EPA (www.epa.gov/compost) for copies of the full studies. The authors can be reached at hoffman.stephen@epa.gov or mahmud.shahid@epa.gov.